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International standards for solar heating collectors and systems

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Abstract

Introduction

ISO TC180 is the international standards committee that covers activities in the Solar heating and cooling space. The scope of the work of the committee is "Standardization in the field of solar energy utilization in space and water heating, cooling, industrial process heating and air conditioning".

1. Structure

The work of ISO TC 180 is undertaken in subcommittees and working groups utilizing the skills of experts from 26 participating countries and the input from 37 observing countries.

There is also significant work undertaken collaboratively with CEN TC312 and IEA SHC Task 43. CEN TC312 is leading the current revision of the European collector test standard EN12975 which under the Vienna Agreement between ISO and CEN is a draft international standard intended to become the ISO 9806 series of standards. Additionally, IEA SHC Task 43 is collaborating with TC180 and CENTC312 on standards and certification processes to assist in breaking down barriers to international trade. This work is reported in other papers at this conference [2] and [3].

2. Current work on collectors:

As well as the CEN-lead revision of ISO 9806 a number of new projects are underway, one with CEN lead and two lead by ISO TC180/WG3. Three New Work Item Proposals for a multi-part standard on collector components and materials are currently under ballot. These are:

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- ISO lead – Part 1: Evacuated tube durability and performance
- ISO lead – Part 2: Heat pipes for evacuated tubes - Durability and performance
- CEN lead – Part 3: Durability of absorber surface.

Evacuated tube collectors have a considerable proportion of the total installed capacity of solar collector types. Evacuated tube collectors consists of several different types, each evacuated tube type has its specific technical requirements and test methods that are quite different from flat plate collectors. Therefore, the newly formed ISO/TC 180/WG 3, "*Collector components and materials*", has started working on formulation of standards for evacuated tubes.

Evacuated tubes can be classified according to absorber material and construction into double-glass evacuated tube and glass-metal sealed evacuated tube. These different types of evacuated tubes have been included in the draft document *Part 1: Evacuated tubes – Durability and performance*. Furthermore, as heat-pipe is an important component, which can be used for both the double-glass evacuated tube and glass-metal sealed evacuated tube, the draft document *Part 2: Heat-pipe for evacuated tubes – Durability and performance* has been prepared by WG 3 as well.

3. Current work on systems:

The system test and rating calculation methods developed by ISO TC180/SC4 are nested in the ISO9459 series of standards that includes the following:

- 9459-1: Performance rating procedure using indoor test methods
- 9459-2: Outdoor test methods for system performance characterization and yearly performance prediction of solar only systems
- 9459-4: System performance characterization by means of component tests and computer simulation
- 9459-5: System performance characterization by means of whole system tests and computer simulation

9459-4 is based on a number of test methods used internationally. It is currently in the final stage of drafting.

Keywords: Solar hot water; standards ISO TC180 International Standards

1. ISO TC180 scope and structure

ISO TC180 is the international standards committee that covers activities in the Solar heating and cooling space. The scope of the work of the committee is "Standardization in the field of solar energy utilization in space and water heating, cooling, industrial process heating and air conditioning".

The work of ISO TC 180 is undertaken in two subcommittees and two working groups utilizing the skills of industry, research and testing experts from 26 participating countries and the input from 37observing countries.

The current structure is outlined below;

Subcommittee/Working Group	Title	Secretariat
TC 180/WG 1	Nomenclature	Australia
TC 180/WG 3	Collector components and materials	China
TC 180/SC 1	Climate - Measurement and data	Australia
TC 180/SC 4	Systems - Thermal performance, reliability and durability	USA

Participating Countries (P-Members)		
Algeria	Germany	Saudi Arabia
Australia	Greece	South Africa
Austria	India	Spain
Barbados	Iran, Islamic Republic of	Sweden
Botswana	Italy	Switzerland
Canada	Jamaica	Tunisia
China	Libyan Arab Jamahiriya	United Kingdom
Denmark	Romania	USA
France	Russian Federation	

Observing Countries (O-Members)		
Argentina	Ireland	Oman
Belgium	Israel	Pakistan
Bulgaria	Japan	Philippines
Cuba	Kenya	Poland
Cyprus	Korea, Republic of	Portugal
Czech Republic	Malta	Serbia
Ecuador	Mauritius	Slovakia
Ethiopia	Mexico	Slovenia
Finland	Mongolia	Syrian Arab Republic
Hong Kong, China	Netherlands	Thailand
Hungary	New Zealand	Trinidad and Tobago
Indonesia	Norway	Uruguay

TCs and Organizations in Liaison
ISO TC 59, Buildings and civil engineering works
ISO TC 61, Plastics
European Commission
International Energy Agency
United Nations Economic Commission for Europe
United Nations Educational, Scientific and Cultural Organization

This paper covers the work underway in Working Group 3 and Sub Committee 4. A more complete coverage of ISO TC180's standards work is included in reference [3].

2. Collectors

Under the Vienna agreement between ISO and CEN, the European standards body, ISO standards can be developed under the lead of an ISO Technical Committee or a CEN Technical Committee. This facilitates faster development of new standards and harmonisation of requirements across the world and within Europe.

ISO TC180 is working collaboratively with CEN TC312 and Task 43 of the International Energy Agency's Solar heating and Cooling Program (IEA SHC). CEN TC312 is leading the current revision of the European collector test standard EN12975 which under the Vienna Agreement is a draft international standard intended to become the ISO 9806 series of standards. Additionally, IEA SHC Task 43 is collaborating with TC180 and CENTC312 on standards and certification processes to assist in breaking down barriers to international trade.

This collaborative work is reported in other papers at this conference "*New global test standards for solar thermal collectors*" [1] and "*IEA-SHC Task 43: Research and standardization on solar collector testing towards a global certification scheme*" [2].

Three New Work Item Proposals (NWIP) for a multi-part standard on collector components and materials are currently being balloted.

- Part 1: *Solar energy – Collector components and materials – Evacuated tube durability and performance*
  This NWIP has been proposed by China and will be an ISO-lead Vienna Agreement Project.

- Part 2*: Solar energy – Collector components and materials – Heat pipes for evacuated tubes – Durability and performance*
  This NWIP has also been proposed by China and will be an ISO-lead Vienna Agreement Project.

- Part 3: *Solar energy – Collector components and materials – Absorber surface durability*
  This NWIP has also been proposed by CEN and will be a CEN-lead Vienna Agreement Project. The enquiry ballot at CEN closed on 28 December 2011. It has recently been approved by ISO as a new project.

Both Parts 1 and 2 will cover tests that are primarily targeted to quality assurance testing during production to ensure evacuated tubes and collectors will maintain performance over an adequate lifetime.

3. Systems

System test procedures are covered under the various parts of ISO 9459. Four procedures have been adopted as standards and one is being drafted to become a published standard.

International Standard ISO 9459 was developed to provide methods for comparing solar domestic water heating systems. The development of ISO 9459 is managed by Subcommittee 4 under ISO Technical Committee 180. The system test and rating calculation methods developed by ISO TC180/SC4 are nested in the ISO 9459 series of standards which covers three aspects of performance evaluation:

- rating test based on indoor testing;
- outdoor testing procedures; and
- outdoor testing of components or complete systems and annual performance modelling using computer simulation.

The ISO 9459 series of standards includes the following:

- 9459-1: *Performance rating procedure using indoor test methods*
- 9459-2: *Outdoor test methods for system performance characterization and yearly performance prediction of solar only systems*
- 9459-4: *System performance characterization by means of component tests and computer simulation*
- 9459-5: *System performance characterization by means of whole system tests and computer simulation*

9459-3, "*Performance test for solar plus supplementary systems*" was withdrawn in 2011 and is not expected to be renewed.

Because of the diversity in the design configurations of solar water heating systems, it has been difficult to define a generalized test method and a performance model that can be used for all designs. Since international consensus for a single test method, or even a standard set of test conditions, has not yet been achieved, the available test methods have been set forth as separate parts of 9459 so work can proceed on each approach independently. There are three different basic approaches: a rating test, a correlation procedure, and computer simulation based on component testing.

9459-1 is a physical test of a complete, specific solar water heating system under a specified set of operating conditions. This rating test approach subjects every system to the same conditions for ambient weather (including solar radiation) and use of the heated water. The advantage of this approach is that every system is tested under exactly the same conditions. This makes comparing one system's performance to another very easy. The disadvantage of this approach is that the test must be conducted on every system design configuration and under every set of weather / load conditions that a comparison is desired.

9459-2 is also based on a physical test, but its use is limited to solar-only and solar-preheat system designs. It is also limited to a single evening hot water usage profile. It does offer the ability to predict system annual performance based on daily mean data for ambient air temperature, solar radiation, and

water mains temperature through a correlation procedure. This is often referred to as the Complete System Testing Group (CSTG). An advantage of this approach is that a generic correlation model is used to simulate the performance of all system configurations. However, this is also a disadvantage because specific details of a system's configuration cannot be simulated to determine their impact on overall system performance.

9459-4 and 9459-5 take the approach of using test data to calibrate generic computer simulation models. This is often referred to as Component Test, System Simulation (CTSS).

9459-4 references or specifies test procedures for every component in the solar water heating system. The test data on these individual components is used to calibrate generic computer simulation models for each component. The simulation model for the system combines the individual component models to predict the performance of the complete system under any specified weather and hot water usage conditions. The advantage of this approach is that each component in the solar water heating system can be modelled to accurately represent its specific performance and impact on every other component in the system.

The software can also be modified to simulate the performance of other sizes (families) of components without additional physical testing. Hourly weather data for any desired location is used to define the climate. The usage of hot water (load profile) can also be defined hourly in a repeating pattern that varies daily, weekly, and/or seasonally.

The disadvantage of this approach is that a computer model must be developed for every system component. While generic models are already available for most common components, new concepts require detailed modelling of the physical performance of that specific component. The computer model used in 9549-4 is readily available and can be customized by the user.

9459-5 uses a proprietary software package that has been validated for a defined set of system configurations. The software requires training to understand its use and it cannot be modified by the user for other system design configurations. The software is calibrated with data from a Dynamic System Testing Program (DST) in which the thermal performance of the system is measured. For those system designs where it has been validated, hourly weather and water mains temperature data can be used to predict annual system performance.

ISO 9459-1, 9459-2, and 9459-5 are currently fully approved international standards. 9459-4 is in the final draft international stage (FDIS) and is expected to receive final approval this year. Subcommittee 4 has agreed to revise 9459-2 and 9459-5. Work on these revisions is expected to begin soon.

4. Conclusion

There is a clear trend to increasing international trade in solar products. Industry and consumers require standards that are appropriate to the geographic location of use, and that unnecessary costs of duplicate product testing for different jurisdictions is avoided. ISO Standards form the basis of a number of National Standards and are being harmonised with European Standards. Consistent standards are important for reduction of non-tariff barriers to the increasing international trade in solar products.

Current ISO solar collector and system standards are being revised to ensure that the standards are suitable for products manufactured for export and import and that performance in climates appropriate to developing markets can be assessed using ISO standards.

References

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[3] Guthrie and Mafucci *International Standards for Solar Water Heaters* ESTEC 2009